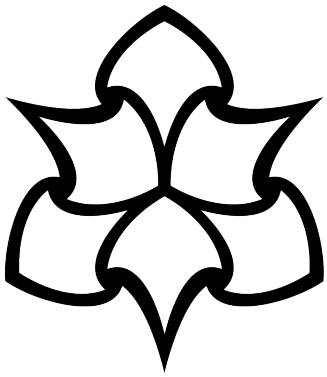


HOLDING BACK THE BUSHES,
Earth Observation for monitoring and preventing land degradation

Land degradation and desertification (LDD) is a significant problem across the world, affecting soil fertility and, in some areas, even leading to food insecurity. Researchers in the **LanDDApp** project aim to gain deeper insights into LDD in the North West Province of South Africa by assessing the extent of bush encroachment, a process often linked to LDD, as **Dr Elias Symeonakis** explains

The encroachment of bush or woody vegetation into previously grassy areas is a serious problem in South Africa's North West Province, leading to reduced soil fertility and even food insecurity in some areas. As the Principal Investigator of the LanDDApp project, Dr Elias Symeonakis aims to assess the extent of the problem in the area. "With this project we are trying to monitor the growth of woody vegetation in North West Province. We are using remote sensing tools and data sets to identify woody vegetation as accurately as possible," he explains. Woody vegetation can be identified highly accurately with modern remote sensing technologies. By combining recent estimates with earlier data from the '80s and '90s, researchers can gain new insights into how African savannahs are changing and evolving over time. "Where we see steady increases in woody vegetation, we can identify those areas as potential hotspots of land degradation and desertification (LDD)," continues Dr Symeonakis.

Typical land cover types of the the study area: (a) woody vegetation; (b) grassland; (c) cropland, and (d) non-vegetated land.

Land degradation and desertification

This affects many areas across the world, with more than 50 percent of the Earth's land surface thought to be prone to LDD, which can be broadly defined as the inability of the land to provide those services that it would have been able to provide previously, due to a combination of anthropogenic processes. A number of reasons have been put forward to explain the growing severity of the LDD problem, yet Dr Symeonakis says the primary factor is widely thought to be climate change. "A lot of blame was previously put on the management of the area by the local community and the herdsmen, so it was thought to be related to issues like over-grazing, fires and bad management practices, generally. Nowadays we are confident that climate change is the most important factor," he outlines. There is now a concerted focus in research on understanding the extent of the problem, an issue that lies at the core of the project's work. "We're looking at the problem of bush encroachment specifically," says Dr Symeonakis.

The impact of this on local eco-systems can be serious, affecting the availability of food for local animals and disrupting the local economy. The problem is particularly acute in the North West Province, where livestock are a key source of income. "When these grasses have been taken over by the bushes, by the woody vegetation, then cattle, the only source of income for many locals, becomes malnourished," outlines Dr Symeonakis. This has knock-on effects on the local economy, underlining the wider importance of the project's work. "Alongside identifying the presence of woody vegetation, we also aim to map its density, i.e. the percentage of it in specific areas," continues Dr Symeonakis. "If an area that previously had 10 percent shrub coverage, with the rest of it typically being grasses and bare soil, changes to 20 percent woody vegetation, then that constitutes a 100 percent increase, which can be quite alarming. It's important to know if we can identify the percentage of woody vegetation with sufficient accuracy."

This would allow researchers to build a deeper picture of regional variations, and from that identify in which areas it might be necessary to take mitigation measures. The NW Province itself covers an area of approximately 100,000 km^2, and there are variations across the region in the extent of land degradation. "On the western side of the province, the situation is pretty serious. There are poorer communities and smaller properties which don't have the resources necessary to deal with the problem," says Dr Symeonakis. The way the land is used is also an important consideration. "There are areas in which bush encroachment is a bigger problem than others. It might be that the land is really only used in some areas for raising cattle for example, whereas in other parts of the North West Province, it is mostly used for crop cultivation," says Dr Symeonakis. "In the central part of the Province, most of the land is devoted to agricultural practices, and bush encroachment is less of a problem there."

The scale of the LDD problem is still a matter of debate, with international authorities and organisations, such as the United Nations Convention to Combat Desertification (UNCCD) looking to gain a

deeper understanding. The project's research will make an important contribution in these terms, helping to identify hotspots of savannah land degradation, which could also enable policy-makers to target mitigation measures more effectively. "Decision-making can be assisted by the types of maps that we can provide with these remote sensing tools. They are highly accurate and they cover large areas," explains Dr Symeonakis. With more data about land quality in specific areas, as well as other relevant information, researchers could then look to map the progression of LDD under certain climate scenarios, a topic Dr Symeonakis plans to investigate in the future. "We haven't done any specific scenario work in this area yet, but it's on the to-do list," he says.

consider the effect of bush encroachment into savannah grasslands that were previously used for feeding livestock, it's entirely reasonable to label it as land degradation," he outlines. Researchers are currently working on the methodology for estimating the percentage of woody cover, while Dr Symeonakis is also keen to build collaborations with projects in complementary areas. "We're working together with ecologists and applying our remote sensing techniques to other areas in East Africa as well as South America and Southeast Asia," he says.

There is also the possibility of including additional data in the models. Dr Symeonakis and his colleagues are looking to combine data sets from drones with other sources, which could enable researchers to differentiate

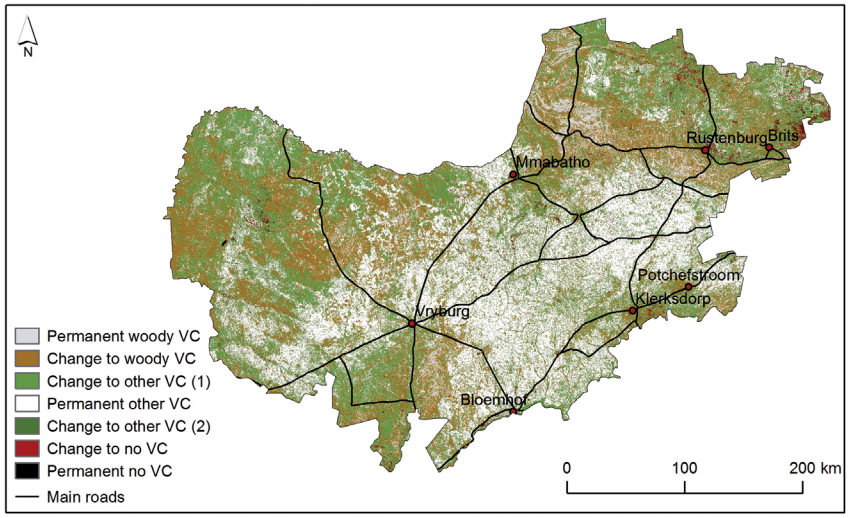
With this project we are trying to monitor the **encroachment of woody vegetation** in the **North West Province**. We are using **remote sensing tools** and **data sets** to identify woody vegetation and its density and how that might be linked to land degradation in the region

Future progression

This work will involve some modelling, based on data about past and present conditions, from which deeper insights can be drawn into the likely future progression of LDD, which is central to wider debates around environmental change and sustainability. While there is still some level of debate as to whether bush encroachment is really a problem - in fact it may even be beneficial for certain species - Dr Symeonakis says it can have a serious impact on some communities. "When we

between woody vegetation species. "The ability to identify different types of woody vegetation is also quite important," he says. Some types of woody vegetation are beneficial, for example providing shelter for animals and fuelwood to humans, which is very different from other invasive thorny and unpalatable species encroaching in areas essential for feeding. "We are in a position where we have all these different data sets and techniques, and we're looking to apply them," says Dr Symeonakis.

During the last 25 years, a large part of the Northwest Province has been converted to woody vegetation cover (depicted here in brown colour).



LanDDApp

Land Degradation and Desertification Appraisal for South Africa

Project Objectives

LanDDApp assessed land degradation caused by bush encroachment in the pilot-study area of North West Province of South Africa. LanDDApp used multi-temporal, multi-sensor and multi-seasonal satellite data to identify degrading areas where mitigation measures are required in order to provide a management tool for the prioritisation of such measures.

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Project Partners

- Humboldt University of Berlin (**Germany**)
- National Technical University of Athens (**Greece**)
- Northwest University (**South Africa**)
- Free State University (**South Africa**)

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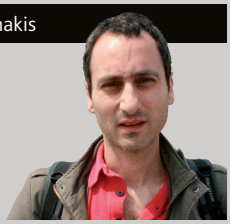
Dr Elias Symeonakis



Dr Elias Symeonakis is a Remote Sensing scientist with a Master's degree in GIS and a PhD in Geography. He is a Senior Lecturer at Manchester Metropolitan University and has previously worked at the CSIRO, Royal Holloway, King's College London, CGIAR/CIAT, the University of Valencia and the University of the Aegean.